PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements in or relating to Containers for the Isolation of Radioactive Matter

We, EVERGLADES LIMITED, a British Company of Spenwood Works, Littleborough, in the County of Lancaster, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to the isolation of radioactive matter during use, storage or transport, that is to say to protective containers for tools, instruments, machines, or other media containing radioactive matter, and includes the packaging of radioactive isotopes.

One of the main difficulties currently met in the use, and particularly the transport, of radioacetive isotopes or other equipment or media arises from the bulk and weight of the packaging for the material. The radioactive media, for storage or transport purposes, has to be first enclosed in a glass or the like container according to the nature of its composition, whereupon the whole is enclosed in a container of a heavy metal. This container usually takes the form of a canister made of lead and having a tight fitting lid.

Although a packaging of this kind normally eliminates the danger of radiation from the enclosed isotopes it is still susceptible to mechanical damage from rough handling with consequent reduction of its efficiency, and in order to avoid this the lead container is usually packed within another and much larger container, generally of wood, for protection from normal shock.

Apart from its wegiht the structure as a whole is cumbersome, and by virtue of its cost it is generally desired to return it when empty, thereby involving the users of the radioactive media in relatively heavy transport charges.

The primary object of the present invention is to avoid the disadvantages inherent in existing packages without impairing their efficiency from a protective aspect.

According to the present invention a container for radioactive isotopes or other radioactive matter is made from a resilient homogeneous unitary mass incorporating a powdered isolating medium of lead or a lead compound and a resilient protective or packing material constituted by rubber or a synthetic resin made from polyvinyl chloride polymer powder, polyvinylidene chloride, polystyrene, polyacrylates or other thermoplastic resins.

Although a predetermined thickness of a bonded mixture of lead powder and either a resilient synthetic resin powder or rubber is not so effective as a sheet or mass of metallic lead of the same thickness in isolating radioactive matter, it will be appreciated that having designed a container of said bonded mixture to meet the requirements of isolation the resiliency of the container and its dimensions will automatically be adequate for ensuring mechanical protection. Further, as the mass of the protective material of the container increases with the cube of its radius, it is desirable for the protective material to lie as close as possible to the active source, and accordingly the inner cavity of the container is preferably just large enough to accommodate with a tight fit a glass sheath, or an aluminium can enclosing a glass sheath, within which the isotope or other radioactive material is housed.

The inner wall of the container may be plain, but by corrugating this, or by pro-

viding suitably shaped fins or ribs projecting radially inwardly from the inner wall of the container, the isotope and its glass sheath may have a firm yet floating support within the container to decrease still further the risk attendant on mechanical shock. Where an isotope is housed within a glass sheath located within an aluminium can, the latter may be packed with paper pulp or other hygroscopic or absorbent material to provide a further resistance to mechanical shock. Again in the absence of an aluminium can a star or other shaped platform may be provided at the base of the cavity of the container for receiving the base of the glass sheath in which event the recesses surrounding said platform may be filled with similar material.

Conveniently the container has a lid or cap which is of the same composite material as the container itself and extends over the entire top area thereof; it also has a depending boss which on the application of the lid to the container has a tight fit with the wall of the inner cavity. This lid is maintained in position by flexible or resilient means which if desired may incorporate a locking device.

The isolating agent utilised in the manufacture of the container preferably is lead powder, but it may be lead oxide where an increase in the thickness of the container is relatively unimportant.

Conveniently the total content of lead or lead components is between 60% and 95% of the whole (by weight), but is preferably in the region of 80%—88%.

Containers in accordance with the present invention are more particularly described with reference to the accompanying drawings in which:—

Figure 1 is a view partly in section of a convenient form of construction illustrating in addition a suitable handle and means for holding the container lid in position.

Figure 2 is a perspective view of a modified form of lid retaining means for a container of Figure 1.

Figure 3 is a view partly in section of a nest of containers; and

Figure 4 is a plan view of a container, which may be the inner container of the nest shown in Figure 3 with the lid removed, wherein the wall cavity for housing an isotope or other radioactive material is corrugated and the base is provided with a raised part of star shape.

In the construction illustrated in Figure 1 a container, made of a resilient homogeneous mass of material incorporating a packing material and a radioactivity isolating material as hereinafter described, is shown at 10 and has a tight fitting lid 11 which is of stepped form complementary to the top of the container.

In order to hold the lid in its operative position a belt 12 made of an extruded nylon strip is fitted tightly around the container at a position adjacent and immediately below a shoulder 13 thereof and carries a pair of diametrally opposed rivets 14 one of which is utilised to join together the opposite ends of the belt in engagement with the container 10. These rivets are adapted to receive the opposite ends of a handle 15 for carrying the container 10 and a fastener for retaining the lid 11 in its closed position. The handle 15 conveniently may be made of nylon strip material as may also the fastener. The latter, however, may be made of rubber reinforced if desired where it engages with the rivets 14.

In the construction according to Figure 1 a fastener 16 comprises a band or belt which consists of a pair of rubber strips separated at the central part thereof by a reinforcing strip of nylon fabric 17 and at the end parts thereof by leather reinforcements 18.

Key hole slots may be formed in said end parts and end reinforcements to enable the fastener to be hooked on to the rivets 14 and held thereon under tension to maintain the lid firmly in position.

The key hole slots are similar to that shown at 19 in Figure 2 which illustrates a modified form of fastener 20 fitted centrally with a metallic locking device 21. In this modification the rubber strip is replaced by two nylon extruded strips, one end of each of which is attached to the nylon belt 12 around the container by the rivets 14, while the opposite ends of the strips are brought together on top of the lid 11 and fixed under tension by the locking device 21 which is of the type known as a "tuck lock" and is widely used on brief and other cases. Although not shown with this form of construction the carrying handle 15 of Figure 1 has key holes for engagement with the rivets 14 after the fastener 20 has been fitted, said handle forming a loop by which the container may be carried with the loop of any desired length, e.g. 30″—36″ to meet particular circumstances.

It will be appreciated that the fastener-handle combination described above enables the fastener 16, 20 and the handle 15 to be applied to the container in a few seconds for the lid to be secured. Likewise removal of the lid and detachment of the fittings may be completed within a matter of seconds.

It is realised that the strength or nature of the radioactive source to be transported may vary and to meet all requirements in this respect, whilst avoiding unnecessary bulk and weight in transport, the container of the present invention may form the inner or innermost of a tightly fitting nest of concentric containers whose inner walls are complementary to the external shapes of the containers they are adapted to receive.

A suitable construction of nested containers is shown in Figure 3 wherein three containers

10, 10*a*, 10*b* are complementarily formed, that is to say the inner cavities of the containers 10*a* and 10*b* are respectively complementary to the outer peripheries of the containers 10, 10*a*, while each has a complementary and tight fitting lid 11, 11*a*, 11*b* respectively.

In the construction according to Figure 4 the wall of the cavity of the container is corrugated as shown at 22, while the base of the cavity has a star shaped step 23 on which the glass sheath for the radioactive material is adapted to rest.

Under certain circumstances where restriction of size is more important than restriction in weight, an inner sheath or pot of lead of a thickness such as for example representing 50% of that normally required to isolate a radioactive source to be transported, may be fitted within a container made in accordance with the present invention, but of reduced dimensions yet sufficient merely to complete the isolation.

In the preparation of the composite material from which the containers are to be made a suitable synthetic resin is polyvinyl chloride polymer powder, but other thermoplastic resins such as polyvinylidene chloride, polystyerene, or polyacrylates may be used. Again small amounts of polyvinyl acetates or polyvinylidene chloride may be added to the polyvinyl chloride polymer powder or originally polymerised therewith.

A plasticiser, such as dioctyl phthalate or dioctyl sebacate, may be incorporated in the mix, the quantity of this being dependent on the degree of resiliency required and the proportion of the lead or other powder to be included. Alternatively a plasticiser such as tricresyl phosphate, which has fire resisting properties, may be chosen. A stabiliser to facilitate manufacture and to prevent decomposition of the polymer powder during the essential heating process may be added, as also a pigment to produce the desired colour of the container and a suitable compound, preferably of a greasy or fatty nature, to operate as a mould release agent.

A typical example of a mix and its method of preparation is as follows:—

45 parts by weight of polyvinyl chloride polymer of a type suitable for making pastes, are mixed in a mechanical mixer with 70 parts by weight of dioctyl phthalate until the paste is smooth. 880 parts of lead powder, capable of passing through a sieve, having a mesh of 50 to the inch, are then added, and after mixing for an approximately additional 10 minutes 2.5 parts by weight of dibutyl tin dilaurate are added. Mixing continues until the paste is thoroughly mixed and smooth.

In a modification 45 parts by weight of polyvinyl chloride polymer of a type suitable for making pastes are mixed in a mechanical mixer with 65 parts by weight of dioctyl sebacate until the paste is smooth. 880 parts by weight of lead powder capable of passing through a sieve, having a mesh of 50 to the inch, are then added, and after mixing for an additional period of approximately 10 minutes 3 parts by weight of basic lead carbonate previously ground with 4.5 parts dioctyl phthalate are added, and mixing continues until the paste is smooth.

Either paste is then poured into a metallic mould of a shape designed to produce the required finished product. Where intricate shapes are involved, in order to enable the product to be removed from the mould it may be necessary to construct the mould of a number of relatively movable parts. When the mould is full of paste it is heated to "gel" the paste and to convert it to its plastic or rubbery nature. Conveniently heating of the mould may be achieved either electrically by means of electrical heating elements incorporated in the mould casing, or by placing the mould within an oven heated by hot air and thermostatically controlled, or again by immersing the mould in a bath of heated fluid such as oil or glycerine, the temperature of which is also thermostatically controlled. The insertion of dibutyl tin dilaurate and lead carbonate in the examples given above is for the purpose of stabilising the P.V.C. during the heating process.

The temperatures required may vary somewhat depending on the nature of the mix but heating to a temperature of 160° C—200° C. should cover all requirements.

Again the time factor will vary with the size of the mould and the thickness of the synthetic resin therein, but it is thought that in the average case a period of 30 minutes to 2 hours should suffice.

A smooth, hygienic, coloured surface is given to the castings if the mould is sprayed internally when at a temperature of 100° C. with a mixture comprising

300 parts by weight of P.V.C. polymer
250 parts by weight of dioctyl phthalate
15 parts by weight of lead sterate; and
50 parts by weight of a white or coloured pigment.

The hot mould causes the sprayed paste to semi-gel and become dry, whereupon the lead-containing paste can be poured into the mould without disturbing this surface. When the final high temperature is applied to complete the gelation the paste which is sprayed on the mould becomes a part of the main mass giving a smooth, hygienic and coloured surface which is firmly fixed and is unlikely to come off. This eliminates the use of a separate lacquer in finishing the castings.

Where the basic material is rubber as distinct from polyvinyl chloride or the like a suitable mix in accordance with the present invention under such circumstances may con-

sist of the undermentioned ingredients by weight:—

Rubber	100 parts
Lead powder	100 parts
Litharge	95 parts
Sulphur powder	10 parts
Zinc oxide	5 parts
Stearic acid	0.5 parts

In making this mix it will be appreciated that the litharge is utilised as an accelerator for speeding up the rate of vulcanisation, and as a protective medium. The sulphur powder is the required vulcanising agent, the zinc oxide also promotes vulcanisation by stimulating the accelerator, and the stearic acid acts as a softening and dispersing agent to facilitate the mixing operation.

After the mix has been completed it is transferred to a mould, and the temperature raised slowly to approximately 141° C. whereupon it is maintained at this temperature for approximately two hours under pressure.

WHAT WE CLAIM IS:—

1. A container for radioactive isotopes or other radioactive matter which is made from a resilient homogeneous unitary mass incorporating a powdered isolating medium of lead or a lead compound and a resilient protective or packing material constituted by rubber or a synthetic resin made from polyvinyl chloride polymer powder, polyvinylidene chloride, polystyrene, polyacrylates or other thermoplastic resins.

2. A container as claimed in Claim 1 which is in the form of a cylinder having a tight fitting yet removable lid of similar resilient homogeneous material.

3. A container as claimed in Claim 2 in which the lid is adapted to be maintained in position on the container by a belt fastener which passes across the lid and the ends of which are detachably connected to rivets diametrally mounted on a nylon or other band or belt surrounding the cylinder.

4. A container as claimed in Claim 2 in which the lid is adapted to be held in position on the container by a pair of strips of nylon material the interengaging ends of which are adapted to be interlocked and the opposite ends of which are detachably connected to rivets diametrally mounted on a nylon or other band or belt surrounding the cylinder.

5. A container as claimed in Claim 1 which is in the form of a number of nested complementarily formed cylinders each having its own tight fitting lid which collectively are also complementarily formed substantially as and for the purpose described.

6. A container as claimed in Claim 1 in which the content of the lead or lead compound isolating medium is between 60% and 95% by weight of the total mass from which the container is made.

7. A container as claimed in Claim 6 in which the content of the isolating medium is between 80% and 88% by weight of the total mass from which the container is made.

8. A container as claimed in Claim 1 which is made from a material including by weight 45 parts of polyvinyl chloride polymer, 70 parts of dioctyl phthalate, 880 parts of lead powder capable of passing through a sieve having a mesh of 50 to the inch and 2.5 parts of dibutyl tin dilaurate.

9. A container as claimed in Claim 1 which is made from a material including by weight 45 parts of polyvinyl chloride polymer, 65 parts of dioctyl sebacate, 880 parts of lead powder capable of passing through a sieve having a mesh of 50 to the inch and 3 parts of basic lead carbonate previously ground with 4.5 parts dioctyl phthalate.

10. A container as claimed in Claim 1 which is made from a material incorporating by weight 100 parts rubber, 95 parts litharge, 100 parts lead powder, 10 parts sulphur, 5 parts zinc oxide and 0.5 parts stearic acid.

11. In the manufacture of the container as claimed in Claim 8 the method of preparing the material substantially as described herein.

12. In the manufacture of the container as claimed in Claim 9 the method of preparing the material substantially as described herein.

13. A container for radioactive isotopes or other radioactive matter substantially as described with reference to, and as illustrated in, the accompanying drawings.

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PROVISIONAL SPECIFICATION

Improvements in or relating to the Isolation of Radioactive Matter

We, EVERGLADES LIMITED, a British Company of Spenwood Works, Littleborough, in the County of Lancaster, do hereby declare this invention to be described in the following statement:—

The present invention relates to the isolation of radioactive matter during use, storage or transport, that is to say to protective shields or containers for tools instruments machines or other media containing radioactive matter, and includes the packaging of radioactive isotopes.

One of the main difficulties currently met in the use, and particularly the transport, of radioactive isotopes or other equipment or media arises from the bulk and weight of the

packaging for the material. The radioactive media, for storage or transport purposes, has to be first enclosed in a glass or the like container according to the nature of its composition, whereupon the whole is enclosed in a container of a heavy metal. This container usually takes the form of a canister made of lead and having a tight fitting lid.

Although a packaging of this kind normally eliminates the danger of radiation from the enclosed isotopes it is still susceptible to mechanical damage from rough handling with consequent reduction of its efficiency, and in order to avoid this the lead container is usually packed within another and much larger container, generally of wood, for protection from normal shock.

Apart from its weight the structure as a whole is cumbersome, and by virtue of its cost it is generally desired to return it when empty, thereby involving the users of the radioactive media in relatively heavy transport charges. Again with the known forms of construction the danger is always present, such as for example in the case of an aeroplane crash during transport of the container, of a fire of sufficient capacity to cause the container to disintegrate and thus release the radioactive material.

The primary object of the present invention is to avoid the disadvantages inherent in existing packages without impairing their efficiency from a protective aspect.

According to the present invention a part or the whole of the material for isolating the radioactivity of the isotopes or other media is incoporated with the protective or packaging material to form a resilient homogeneous unitary mass.

Conveniently the radioactive media may be housed within a shield or container formed from a mixture of a metallic powder, such as lead, and a resilient plastic or natural or synthetic rubber cast, moulded or otherwise bonded as desired into a homogeneous mass. While it may take any desired shape, externally the shield or container preferably is a cylinder.

Although a predetermined thickness of a bonded mixture of lead powder and either a plastic powder or rubber is not so effective as a sheet or mass of metallic lead of the same thickness in isolating radioactive matter, it will be appreciated that having designed a container of said bonded mixture to meet the requirements of isolation the resiliency of the container and its dimensions will automatically be adequate for ensuring mechanical protection. Further, as the mass of the protective material of the container increases with the cube of its radius, it is desirable for the protective material to lie as close as possible to the active source, and accordingly the inner cavity of the container is preferably just large enough to accommodate with a tight fit the glass sheath for the isotope or other radioactive material. By providing suitably shaped fins or rips projecting radially inwardly from the inner wall of the container the isotope and its glass sheath may have a firm yet floating support within the container to decrease still further the risk attendant on mechanical shock.

The recesses between the ribs on the inner wall may be filled with paper pulp or other hygroscopic or absorbent material, while if desired a star or other shaped platform may be provided at the base of the cavity for receiving the base of the sheath in which event the recesses surrounding it may be filled with similar material.

The container may have a lid or cap which preferably extends over the entire superficial area thereof, and has a depending boss which on the application of the lid to the container has a tight fit with the wall of the inner cavity. This boss also may have a star or other shaped projection, the recesses between the surface in relief being filled similarly to those of the base of the container cavity. In order to reduce the risk of the cap blowing out in the event of the container receiving a heavy blow on its base or side and yet assist in the removal of the cap when required, the depending boss may be coarsely threaded preferably over that part of its axial length where it merges into the body of the cap, in which event the top of the wall of the inner cavity of the container is similarly threaded. In this way the cap is first applied axially to the container with the boss entering the cavity, whereupon it is turned about its axis to complete the closure. The cap may be replaced by a shutter which if desired may slide across the inner cavity to close this.

It is realised that the strength or nature of the radioactive source to be transported may vary and to meet all requirements in this respect, whilst avoiding unnecessary bulk and weight in transport, the container of the present invention may form the inner or innermost of a tightly fitting nest of concentric containers. In such event preferably the inner container only is ribbed internally, the inner wall of the other or others being complementary to the external shape of the container it is to receive.

To increase the resiliency and shock resistance of the container it may have longitudinal holes adjacent its periphery which may be utilised for the reception of locking rods for the lid or cap. These holes may be formed in the container during the moulding or casting operation.

The rods may be threaded at their ends to receive thumb screws or other locking means for preventing inadvertent removal of the lid or cap. Similarly, holes may be formed in the lid and base of the container, to extend

diametrally thereof, or to lie in chordal or parallel relationship.

Alternatively an outer sheath of sponge rubber may be utilised for the purpose of achieving increased resiliency while the lid may be held in position by a spring clip.

Under certain circumstances where restriction of size is more important than restriction in weight, an inner sheath or pot of lead of a thickness such as, for example representing 50% of that normally required to isolate a radioactive source to be transported, may be fitted within a container made in accordance with the present invention, but of reduced dimensions yet sufficient merely to complete the isolation.

The protective agent utilised in the manufacture of the container preferably is lead powder, but it may be lead oxide where an increase in the protective thickness of the container is relatively unimportant, or again, for example, it may be tungsten powder where cost is not vital.

Where a metallic lead powder is utilised its proportion by weight of the mix conveniently could be varied between 60% and 95%, but is preferably in the region of 80%—87%.

A suitable plastic is polyvinyl chloride polymer powder, but other thermoplastic resins such as polyvinylidene, styrene, polyacrylates may be used. Again small amounts of polyvinyl acetates or polyvinylidene chloride may be added to the polyvinyl chloride polymer powder or originally polymerised therewith.

A plasticiser, such as dioctyl phthalate, is incorporated in the mix, the quantity of this being dependent on the degree of resiliency required and the proportion of the lead or other powder to be included. Alternatively a plasticiser such as tricresyl phosphate, which has fire resisting properties, may be chosen.

A stabiliser to facilitate manufacture and to prevent decomposition of the polymer powder during the essential heating process is added, as are also a pigment to produce the desired colour of the container and a suitable compound, preferably of a greasy or fatty nature, to operate as a mould release agent.

A typical formula which is given solely by way of example has the following parts by weight:—

Polyvinyl chloride polymer powder -	18
Dioctyl phthalate - - - -	27
Basic lead carbonate - - -	1
Metallic lead powder - - - -	280

Preferably a lead powder should be capable of passing through a 50 mesh sieve.

The plastic powder, the plasticiser, lead powder, stabiliser, and pigments are mixed together for approximately 30 minutes; the resultant paste is then formed into a mould of the required internal shape compatible with that of the containers to be formed and is heated for approximately 45 minutes at a temperature in the region of 170° C.; the mould is removed from its heating source and is cooled. After the mass has been cooled it is removed from the mould and if necessary any flash material may be removed by machining.

Where rubber is substituted for a plastic, the usual technique of rubber moulding may be utilised after incorporation of the required lead or other powder, constituting the protective agent.

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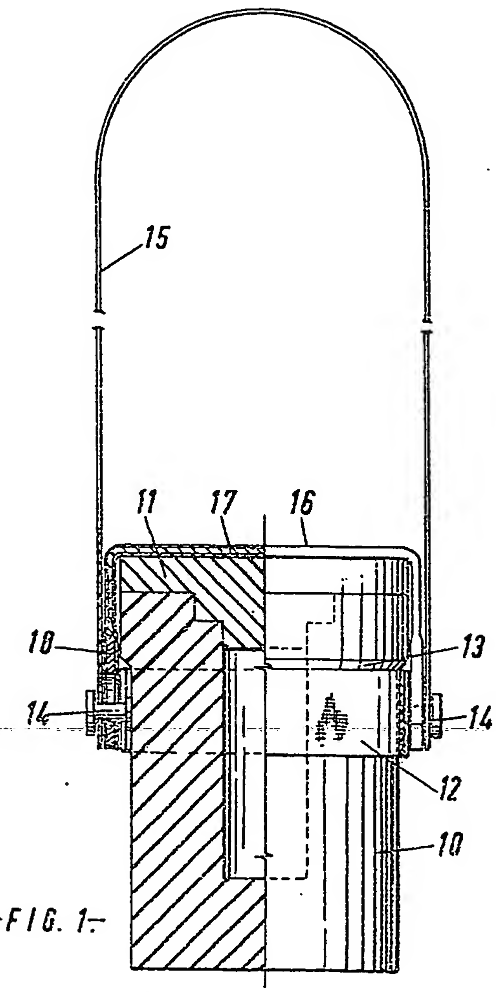
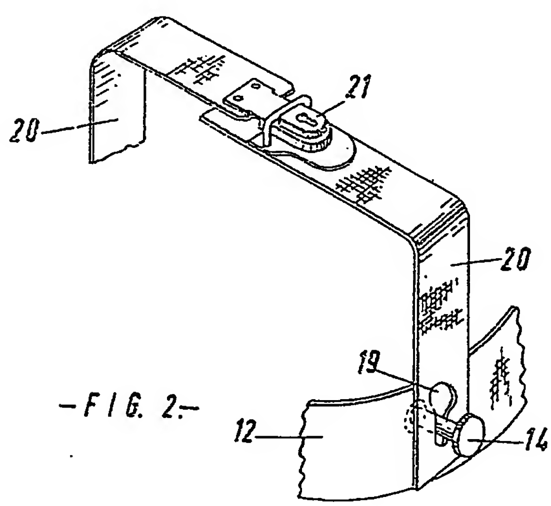
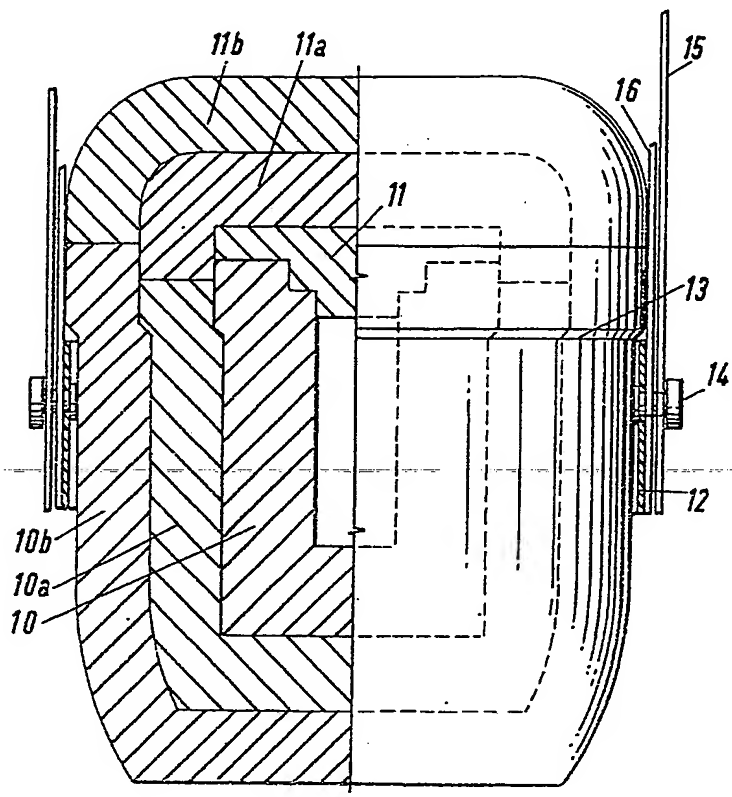


-FIG. 1.-

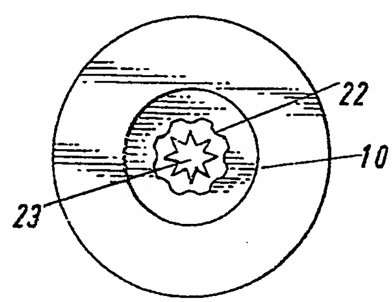


-FIG. 2.-

849,655 COMPLETE SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale.
SHEETS 1 & 2



–FIG. 3.–



–FIG. 4.–

849,655 COMPLETE SPECIFICATION
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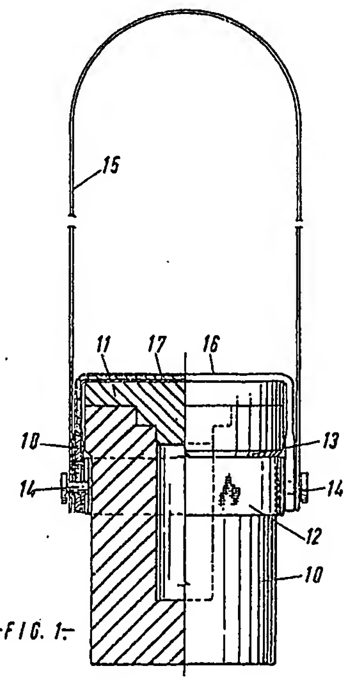
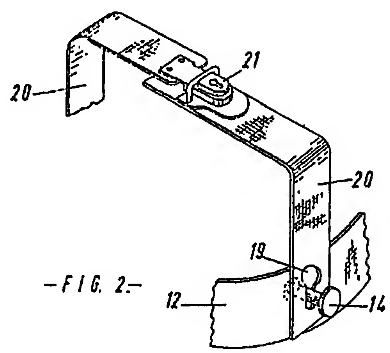
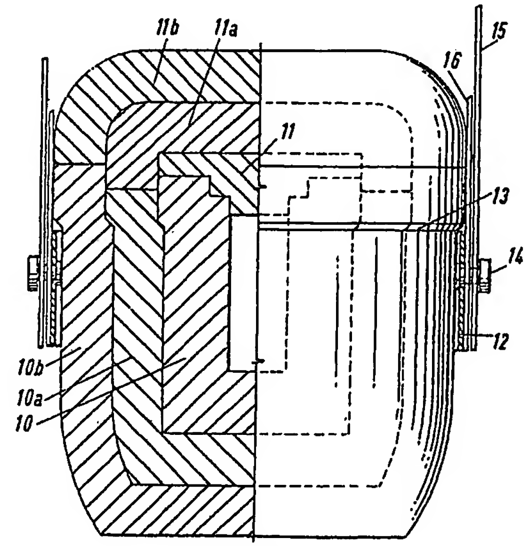
SHEETS 1 & 2



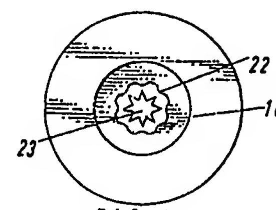
-FIG. 1.-



-FIG. 2.-



-FIG. 3.-



-FIG. 4.-